Evaluation of Radar Constraints on the Shape of Eros

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With enough echo strength, resolution, and orientational coverage, one can use radar delay/Doppler images or Doppler-only images (spectra) to constrain a target's 3-D shape. For data providing a nearly equatorial view, one can obtain unique information about the object's pole-on silhouette (either the silhouette, S, or its convex hull, H), but not about shape components perpendicular to the equatorial plane.

Of the several asteroids imaged at useful resolutions by spacecraft, Eros is the first for which radar-derived shape constraints are available. Echo power spectra were obtained at Goldstone in 1975 (Jurgens and Goldstein 1976) with a nearly equatorial view and a total signal-to-noise ratio (SNR) of only 60 sigma.

Ostro et al. (1990) used spectral edge frequencies to estimate H, and Mitchell et al. (1998) used all echo spectral elements (~15 times more data points) to constrain concavities within the hull.

The radar-derived estimates of Eros' hull and of the silhouette itself reproduce the object's pole-on shape characteristics within the uncertainty intervals that were presented graphically in the cited papers. Simulations described in Ostro et al. indicated that because of the low SNR of the radar echoes, estimation of the hull required smoothing of the spectra in frequency and/or rotation phase. In retrospect, the estimations that used the least amount of smoothing produced the most accurate hull estimate, possibly because of the object's extreme elongation.

References:

Jurgens, R. F., and Goldstein, R. M. (1976). Icarus 28, 1-15.

Mitchell, D. L. et al. (1998). Icarus 131, 4-14.

Ostro, S. J., K. D. Rosema, and R. F. Jurgens (1990). Icarus 84, 334-351.